in one direction are numerically equal to the third, acting in the opposite direction. Taking symbols used in the United States [and assigning to each a value used by Dines (Nature, Dec. 12, 1918, p. 284)], namely,

ρ for air density [1,217 gm. per cu. m.],

dp/dn pressure gradient [1 mb. per 100 km.],

ω velocity of angular rotation of the earth [.00007292],

v wind velocity [to be determined],

ϕ latitude [55° N.],

and r radius of curvature of the wind path as projected horizontally on a plane tangent to the earth's surface at the center of wind-path curvature [334 km.],

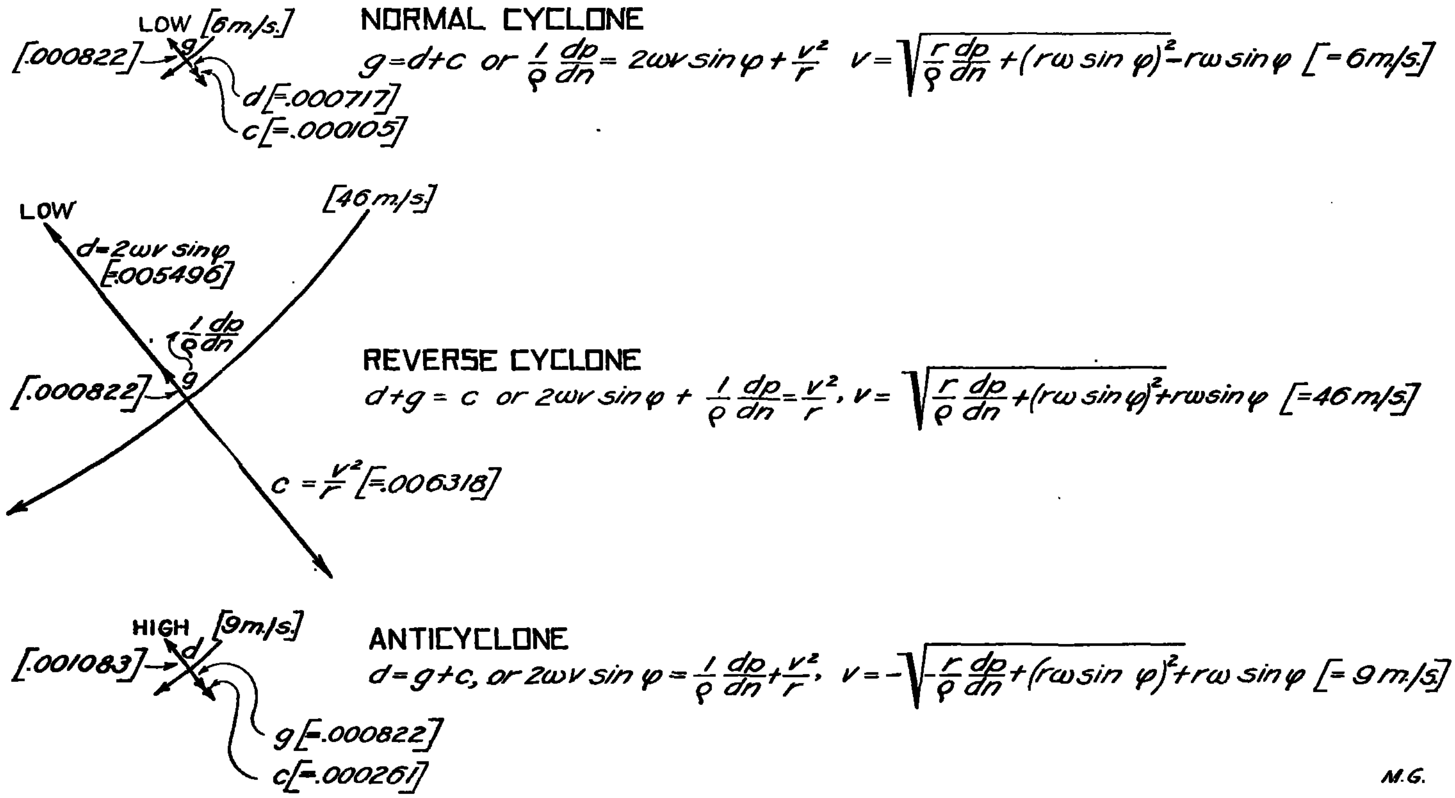
the gradient force, g, is $\frac{1}{\rho}\frac{dp}{dn}$, [.000822],

the deflective effect of the earth's rotation, d, is $2\omega v \sin.\phi$ [.0001195v],

and the centrifugal force, c, is v^2/r [.000003v^2].

their interferences, thus, would be more likely to make counterclockwise whirls than the reverse.

What is the condition of relatively weak clockwise whirls? The reverse cyclone has the deflective and gradient forces toward the inside of the curve equal numerically to the very large centrifugal force toward the outside ($d+g=c$; see fig.); and it is only at high velocities that this centrifugal force can be large enough to equal both the deflective force and the gradient. At smaller velocities the centrifugal force is always less than the deflecting force, and so, to maintain the equation, the centrifugal force must have the gradient force acting with it to keep the wind on a given curved path ($d=c+g$; see fig.). In other words, there would have to be a high instead of a low pressure center on the inside of the curve. Weak clockwise impulses would, therefore, be associated with anticyclones instead of cyclones.—*C. F. Brooks.*



Let us consider these in the normal cyclone (counterclockwise in the Northern Hemisphere), the reverse cyclone (clockwise in the Northern Hemisphere), and the anticyclone, using, for illustration, diagrams drawn to correspond numerically to the values assigned above.

The given latitude, gradient, and radius of curvature in Dines's example would thus require a wind of 6 m./s. in the counterclockwise cyclone and one of 46 m./s. in the clockwise. Even if the gradient should approach zero the velocity requisite to keep the clockwise cyclone going would not fall below 40 m./s.

Since with ordinary gradients and radii of curvature the velocity necessary to maintain a clockwise cyclone is so high, it is obvious why such a reverse cyclone does not get started on a scale larger than a dust whirl or possibly a tornado. Tornadoes are so generally counterclockwise (1) because the necessary initial impulse does not need to be so great to start one in this direction as in the other, and (2) because in tornado regions there is the south wind on the east and the north wind on the west;

ADDITIONAL NOTE ON CLOCKWISE AND COUNTERCLOCKWISE CYCLONIC MOTIONS WITH APPLICATION TO THE FLIGHT OF AIRCRAFT.

Meteorologists easily perceive the slight possibilities that the clockwise motions, shown in Mr. Dines's note to be dynamically possible, can actually get agoing and be sustained on any considerable scale in nature. Nevertheless, no such limitations arise in the case of the flight of airplanes, and with a trifling alteration in one term the equations for the atmospheric motions become fully applicable to the flight of birds and aircraft. It may, therefore, be interesting to examine the results to which these considerations lead.

The basic equation governing all motions of bodies moving horizontally at a uniform velocity in curved paths over the earth's surface is:

$$\frac{mv^2}{r}=Fm\pm fm \qquad (1)$$

in which m is the mass of the body; v its velocity; r the momentary radius of curvature of the path (neglecting the curvature of the earth); F, taken positive in all cases, is any reaction or resultant of the forces per unit mass of the body and arising within the aircraft (a rudder reaction or component of the sustaining air pressure, for example) which acts to turn the flight of the craft to the right or left as may be desired; and the quantity f is here the familiar expression for the deflective force per unit mass of the earth's rotation on a body moving at velocity v in latitude ϕ, viz,

$$2v\omega \sin \phi$$

In the Northern Hemisphere the plus sign in (1) will apply in all cases in which the aircraft turns to the right or clockwise, while the minus sign represents counterclockwise or left-hand turns, with vice versa effects in the Southern Hemisphere.

Our present purpose is to examine the results required to satisfy equation (1) under conditions which may ordinarily occur. Solving for r we get for forces on unit mass

$$r=\frac{v^2}{F\pm f}. \qquad (2)$$

Confining attention to velocities of 40 meters per second at latitude 50 we have for r in meters

$$r=\frac{160000}{F\pm .4469 \text{ dynes}} \qquad (3)$$

plus for right-handed, minus for left-handed turns.

Solving equation (1) for v we get:

$$v=\sqrt{Fr+(r\omega\sin\varphi)^2}\pm r\omega\sin\varphi \qquad (4)$$

plus for right-hand and minus for left-hand turns.

For a left-hand turn of a given radius, we see from (2) that F will require to be greater, by nearly one dyne (0.893 dyne) per gram of mass than for a right-hand turn, at the same velocity.

This may be a matter of some consequence because when an airplane swings into a turn with normal bank, the forces F and the weight of the craft are sine and cosine components of the sustaining air pressures. Accordingly, the smaller the force F the more completely the weight of the machine is supported and the less the loss of altitude, which is unavoidable in any case.

Applied to gliding, equation (4) indicates that the glide may be prolonged by executing a long turn to the right rather than to the left. For maximum effect, F must become zero and involve no banking, thus affording maximum support with $v=2r\omega\sin\phi$. To execute the same glide in a left-hand turn, the value of F would require to be $2f$, accompanied by corresponding banking and loss of sustaining effort.

When a machine is climbing under a given expenditure of power and along a curved flight, the ascent will be more rapid clockwise than counterclockwise.

When a pilot sets out to steer a straight-away course by compass, for example, he always finds himself, even in quiet air, headed away from course in a few minutes. The force F, without his knowledge or intention, has turned the machine to the right or left as the case may be. What are the probable values of F in such cases?

Let us assume the pilot disregards deviations from course that are less than one-quarter point of the compass, say, about 3°. Also, assume that on the average he must rectify his course once every 60 seconds, that is, the forces $F+f$ turn his craft 3° from course every 60 seconds.

From these data it is easy to show that for right-hand turns at 40 meters per second, latitude 50°, F must be $6.812\,f$, and for left-hand turns, $8.812\,f$, in which, under the assumed conditions $f=0.447$ dynes. F and f, it must be remembered, are forces per gram of moving matter.—*C. F. Marvin.*

WEATHER MAPS IN LONDON NEWSPAPERS.

On January 1 the Morning Post [and later the Times and Daily Telegraph] commenced the publication of the daily weather chart prepared by the Meteorological Office from the 6 p. m. observations. The area included extends from Iceland in the northwest to Corsica in the southeast, the British Isles having a central position and the west of continental Europe, from Scandinavia to the Pyrenees being shown. Isobars are given for intervals of 5 millibars, and the lines are numbered at one end with the pressure in millibars, at the other with the height of the mercurial barometer in inches and hundredths. As the map extends across two columns it is very clear and legible, a great advance on any previous presentation of a weather chart in a British newspaper.

In introducing the new feature the Morning Post, under the heading of "A fascinating daily study," started a series of meteorological articles with the happy quotation from Ruskin:

"While the geologist yearns for the mountain, the botanist for the field, and the mathematician for the study, the meteorologist like a spirit of a higher order than any, rejoices in the kingdom of the air."

The writer understands that a new era in public appreciation of meteorology began with the armistice, and he says: "In all educational establishments, from the universities, through the training colleges, down to the elementary schools, familiarity with the daily Weather Map, and its indications, has now become an imperative necessity. Lectures based upon the many erroneous theories of pre-Weather Map days which are found in most textbooks, and illustrated by diagrams of a generation or half a century ago, are out of date—they are the dried-up, lifeless bones out of which there comes no sustenance. What is now required is the living thing, something that appeals to and interests the scholar because he feels that he is being taught to appreciate what he is experiencing at the moment. This living thing is the Weather Map which a very large proportion of the readers of the Morning Post will have served up with breakfast every morning, and in more distant regions by midday."[1]

The Post and Times both give a description of the general conditions prevailing at 6 p. m., together with the changes then in progress and their probable effect on the weather conditions likely to be experienced over the British Isles during their course. The needs of aviation are also provided for, and a table is given each day in the Times showing the direction and velocity of the wind at 2,000, 5,000, 10,000, and 15,000 feet above the ground.

This information as now supplied is far more complete than was possible in the early days of the war, and should help to stimulate an intelligent interest in meteorological matters among the general public.

Wireless reports from ships out at sea are, it is understood, to be added to the reports as soon as the new service is organized.[2]

[1] From Symons's Met'l Mag., Feb., 1919, 54: 1-2.

[2] Quart. Jour. Roy. Met'l Soc., London, Jan., 1919, vol. 45, p. 83. See also Nature, London, Jan. 30, 1919, p. 427, and Sym. Met'l Mag., Mar., 1919, p. 19.